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RECORDS OF THE QUEEN VICTORIA MUSEUM, LAUNCESTON

GEOLOGY OF PORTION OF THE WESTERN TIERS

By

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ABSTRACT

A geological map is presented of an area of some 160 square miles of the Western Tiers and the adjacent plateau and lowlands. Some 4000 feet of Permian and Triassic sediments are described and a number of new formation names are introduced. Some features of the Jurassic dolerite which caps the sedimentary sequence are discussed. Comments on the structure of the area conclude the paper.

INTRODUCTION

The area described includes portion of the Central Plateau to the north of Great Lake, the marginal escarpment of the plateau between Western Rivulet and Woodside Creek and the lowlands adjacent to that scarp. The total area is approximately 160 square miles.

The field work was carried out by tracing geological boundaries on the ground and transferring these to aerial photographs. The base plans were prepared from aerial photographs using the slotted template method. This work and subsequent geological draughting was carried out by the Geological Section of the Hydro-Electric Commission.

Access to the area may be gained via the Lake Highway in the western portion of the area and via various second-class roads from the Midland Highway which lies some thirty road-miles east of the area. Within the area a system of secondary roads, indicated on the map squares, gives access to the foot of the scarp. Only the Lake Highway in the west and the Palmer River track in the east give vehicle access to higher levels so that most of the investigations have entailed journeys on foot from the lower levels.

Topographic Divisions

The area studied comprises three topographic divisions each characterised by distinctive climatic conditions and vegetation.

1. *Plateau Division*

The Plateau division extends from the depression occupied by Great Lake (Top water level 3381·8 feet) in the south-west of the area to the edge of the scarp. The general terrain is that of a dissected plateau. Flat floored, marshy valleys separate boulder-strewn, rocky ridges some of which have precipitous sides. Examination of the geological maps indicates that the disposition of the marshy valleys is controlled by structures (shear zones and faults) in the dolerite bedrock.

The vegetation of the marshy valleys is restricted to grasses and mosses while the rocky ridges support patches of stunted eucalypts. The restricted vegetation is probably a reflection of the extreme winter climate of the plateau. The precipitation is about thirty-five inches per annum, part of which is in the form of snow. Because of the low winter temperatures a snow blanket is maintained for weeks at a time and only in areas sheltered by ridges can the eucalypts survive.

2. *Escarpment Division*

The Escarpment Division may be defined as the area between the margin of the plateau and the one thousand feet contour. The profile of this escarpment is typically concave, the cliffs and scree fields of the upper levels giving way to timbered slopes decreasing in grade at lower levels. Major streams incise the scarp in steep sided, thickly timbered valleys but much of the drainage is effected in shallow migratory channels in the deep talus deposits on the slopes.

The climate is less extreme than on the plateau and the rainfall somewhat higher. The limited record suggest a figure in excess of forty inches per annum. Snowfalls occur on these slopes but the snow melts rapidly producing high run-offs and local flooding in the water-courses. The less extreme climate is reflected in the vegetation which is dense with good stands of milling timber up to the three thousand feet contour. Above the three thousand feet contour the vegetation is still thick

but is somewhat stunted partly because of the movements of the scree and talus and partly because of the inability of this material to support lush vegetation.

3. *Lowlands Division*

The Lowlands Division occupies the north-eastern portion of the area. It includes the pediment of the scarp and the low dolerite hills north-east of the scarp-forming fault.

The climate and vegetation differ from those of the plateau escarpment. The extremely localised showers which supplement the escarpment rainfall are absent and snowfalls are very rare. Lightly timbered grasslands and shallow migratory streams characterise the division though some degree of permanence in the stream courses exists beyond the line of the scarp-forming fault where the channels are cut into the dolerite bedrock. Storms on the escarpment cause periodic flooding of the gently sloping pediment so that the agricultural use of this area is restricted to grazing.

STRATIGRAPHY

A gently dipping sequence of Triassic and Permian sediments with an overall thickness of approximately 4000 feet is overlain by a thick and, in part, transgressive dolerite sill. The products of erosion of these rocks form extensive deposits in some parts of the area. The stratigraphic sequence is shown in the table below.

Stratigraphic Table

System	Group	Formation	Rock Type	Thickness	
Recent to Pleistocene			Rock-slides, Scree, Talus, Alluvium, Glacial Deposits		
Tertiary	Launceston (?)		Sands, clays, gravels		
		EROSION INTERVAL STRONG EPEIROGENY AND FAULTING PENEPLANATION AND UNCONFORMITY			
Jurassic			Dolerite	1000′ +	
Triassic		Brady	Sandstones, siltstones, shales	540′	1930′
		Tiers	Thinly bedded sandstones, siltstones, shales	280′	
		Cluan	Sandstones and shales	460′	
		Ross	Massive sandstones	650′	
		DISCONFORMITY (?)			
		Jackey	Shales	140′	
Permian	Ferntree	Eden	Mudstones	20′	687′
		Blackwood	Conglomerate	2′	
		Drys	Mudstones	350′	
		Palmer	Sandstone	5′	
		Springmount	Mudstones	280′	
		Garcia	Sandstone	30′	
	Woodbridge	Weston	Mudstones	30′	265′
		Dabool	Sandstones	40′	
		Meander	Mudstones	195′	
	Liffey	Creekton	Wormcast sandstones	10′	90
		Woodside	Sandstones	35′	
		Kopanica	Shales and sandstones	15′	
		Flat Top	Sandstones	30′	
	Golden Valley	McRae	Mudstones	115′	170′
		Billop	Sandstone	10′	
		Brumby	Calcareous mudstone	45′	
		Quamby	Mudstones	250—330′	
		Stockers	Tillitic conglomerate	340′+	

Quaternary System

Rocks of this system include superficial deposits of Pleistocene and Recent age.

1. *Rock Slides, Scree, Talus*

The collapse of the dolerite cliffs forming the upper margin of the escarpment has produced extensive deposits on the slopes of the scarp. Drilling has proved these deposits in the vicinity of the cliffs to depths in excess of 500 feet.

Major collapses of the dolerite cliffs have resulted in the movement down-slope of coherent masses some chains in extent. During the movement many of these masses have rotated through as much as ninety degrees as indicated by the direction of the prominent jointing. The pronounced vertical jointing is a feature of the dolerite cliffs. These rock-slide masses form cliffs up to 100 feet in height on the slopes below the undisturbed dolerite.

Minor falls from the undisturbed dolerite cliffs produce steep scree slopes at the foot of these faces. The scree blocks (joint blocks of the dolerite) range in size up to 20 feet but mainly fall in the range from two to five feet. The angle of repose of this material is about 30 degrees and slopes of this order are usually encountered at the foot of the dolerite cliffs.

Local movements of the rock-slides and scree material, often associated with the collapse or disintegration of the rock-slide masses, produce "ploughed fields"—areas devoid of vegetation consisting of angular blocks of dolerite without any preferred orientation of jointing.

The weathering of the dolerite of the rock-slides and scree falls produces heavy brown clays. Residual rounded boulders of dolerite in a matrix of this clay obscure the bedrock over much of the escarpment face.

2. *Alluvium*

The transport of material by sheet and rill erosion from the scarp face results in the deposition of a sheet of alluvium on what may be regarded as the scarp pediment. As well as the dolerite boulders and clays of the talus zones it contains clays, silts and sands from the sediments at lower levels on the scarp face. This material may be as much as 30 feet thick near the base of the scarp face and almost certainly thins towards the eastern edge of the area.

3. *Glacial Deposits*

Throughout the Central Plateau abundant evidence of glacial action has been noted. Glacial over-deepening in zones of less resistant bedrock has produced a pattern of depressions. These depressions are now occupied by swamps some of which are known to be underlain by tills. While no tills have been revealed by drilling or surface mapping in the area in question it is distinctly possible that such deposits occur within this area.

Large accumulations of angular dolerite boulders at various points on the surface of the plateau, notable in this area in the vicinity of the lake, may be ascribed to glacial action.

Tertiary System

The extent of the Launceston Tertiary Lake, described by Carey (1947), is not known with certainty but its western margin may well have reached the depression between McRae Hills and the Tiers. Soil tests on clay samples collected along Palmer Rivulet downstream of co-ordinate 4880 E. show that these clays are pre-compressed, presumably by overlying sediments since removed. Further, boulders of "grey billy" and fragments of laterite usually associated with the old (possibly Pliocene) surface of the Lake sediments have been noted in this area. It seems probable, therefore, that some of the clays and gravels which obscure the Permian bedrock in this vicinity belong to the Launceston Group of Tertiary sediments. The thickness of these deposits is of the order of 20 feet.

Jurassic (?) Dolerite

Owing to the lack of fossil evidence in the Triassic sediments and the absence of sediments between the early Jurassic and Lower Tertiary, the age of the dolerite cannot be accurately determined. The writer has followed Hills, Carey and others in assuming a Jurassic age for the dolerite.

The principal occurrence of dolerite in this area is in the form of a thick sill-like sheet intruded at the close of an earlier period of sedimentation which is considered to have extended through the Triassic and probably into the Jurassic Period. The upper surface of the sheet has been exposed and eroded throughout the area. The lower surface of the sill-like intrusion may occur in the sedimentary sequence anywhere above the Ross Formation. Thus its transgressions through the sedimentary sequence total approximately 1250 feet. The maximum measured thickness of the dolerite sill is in excess of 1000 feet though great variations of thickness result from the transgressive nature of its lower boundary and the erosion of its upper surface.

Where the dolerite intrudes a predominantly sand-grade formation, the pure sill-form of the intrusion may be retained over an extensive area. Thus the dolerite-sediment contact low in the Cluan Formation extends, without a major transgression, from Drys Bluff (Map Square 4786) southward to the Palmer Track (Map Square 4785) and in the area east of the Tiers Fault no transgressions from a similar horizon have been noted. Where the lower surface of the intrusion occurs in the Tiers or Brady Formations (both predominantly shale deposition), the contact is irregular and frequent shelving of the contact across the sedimentary sequence occurs. The dolerite-sediment contact may cut across the stratification at any angle but there appears to be some preference for a slope of 5 to 15 degrees.

At several points in the area there is evidence of dolerite intrusion into sediments stratigraphically lower than the Cluan formation. In the north-

west of Map Square 4686 a steep transgression of dolerite through the Permian sequence was mapped. In the north-west of Map Square 4786 an area of dolerite talus suggests the presence of a dolerite intrusion through the Permian sediments. These two intrusions may well be "feeders" of the sill dolerite higher in the sedimentary sequence.

It has been suggested (Professor S. W. Carey—personal communication) that the two areas on Map Square 4885 marked as talus and interpreted as talus "flatirons" by the author are more probably remnants of a thin sheet of dolerite intruded low in the Permian sequence.

Megascopic contact effects in the dolerite are restricted to a narrow zone of fine-grained to glassy dolerite usually closely jointed. Sediments in the vicinity of the contact show "baking" effects which are best developed in the fine-grained members.

The dolerite is well jointed, a strong system of vertical joints producing a structure akin to the organ-pipe structure characteristic of basalts. In addition to cooling fractures a system of strong, near-vertical joints probably related to the Tertiary fault systems is apparent. In areas of exposed rock these major joint systems are evident on the aerial photographs.

The petrology of the Tasmanian dolerite has been described by Edwards (1942) and Prider (1948). Rock magnetism and differentiation of the sill in this area has been discussed by Jaeger and Joplin (1954).

Triassic System

Triassic rocks outcrop on the upper slopes of the scarp along the full length of the Tiers in this area. Further exposures occur to the east of McRae Hills on Map Square 4886. The sequence of flatly dipping Triassic rocks is bounded below by the disconformable contact with the Permian rocks and above by the dolerite sheet. Because of the transgressive nature of this sheet the thickness of the Triassic sequence varies from 650 feet to nearly 2000 feet. Exposures are generally poor, particularly of the shale members, but core drilling in connection with investigations for the proposed Great Lake North power development has provided excellent stratigraphic information over much of the sequence in an area where it approaches the maximum known thickness. The cores provide fresh rock and a continuity of the sequence not available in surface outcrops. Some fourteen diamond drill holes have entered the Triassic rocks along two lines running south-west for a distance of some four miles from points 4825 E. 8505 N. and 4805 E. 8515 N. respectively (Map Square 4885). A generalised sequence throughout the Triassic based where possible on drilling information is shown in the text figure. It represents a system of sediments probably laid down under lacustrine or swamp conditions. The lensing-out of beds in short distances and rapid facies variation make correlation difficult. The Triassic sequence has been divided into four formations.

1. *Brady Formation*

The Brady Formation consists predominantly 'felspathic' sandstones and dark grey shales approximately equal amounts. The sandstone range in grain size from fine to medium. The fresh core is usually mid-grey though some of the fine-grained members are greenish-grey. Black mica flakes on bedding planes assist parting in the direction in most members. Carbonaceous bands up to half an inch in thickness are a feature of the sandstones and coal crescents with a maximum dimension of several inches are also evident. The dark grey shales usually contain plant fragments. Parting along bedding planes is frequently assisted by mica plates on these planes. Some of the shales are faintly and finely banded, the banding being produced by alternations of shale and siltstone or fine sandstone.

As well as the two major lithological types which together constitute more than 90 per cent of the sequence, siltstones, carbonaceous shales and coal seams also occur. The upper half of the formation is characterised by thin coal seams usually some six inches thick but ranging up to 5 feet in thickness. This part of the sequence may possibly be correlated with the upper Triassic coal measures in other parts of the State though such correlations of coal measures are scarcely valid.

The Brady Formation, which has a maximum measured thickness in this area of some 540 feet, is underlain conformably by the Tiers Formation. It was named after Brady's Lookout, a prominent topographical feature and Trig. point in the vicinity of which the drilling (which permitted the study of the formation) was carried out.

The "baking" effect of the dolerite intrusion on the invaded sediments was observed in eight drill holes which penetrated the contact between the dolerite and the Brady Formation. In every case but one the contact occurred within a shale member. The "baking" effected persisted for as much as 30 feet into the sediments and produced a homogeneous buff-coloured clay stone with conchoidal fracture. This material breaks up rapidly on drying. Similar material outcrops in a creek bed near the Lake Highway (4651 E. 8612 N.) and is apparently quite resistant to erosion while normal moisture content is maintained. Silt or sand bands within the zone of "baking" are readily discernible but these, too, have assumed the typical buff colour. The baked siltstones and sandstones do not disintegrate on drying. In the one case where the contact occurred in a sandstone member the "baking" effect was restricted to a few feet and the only discernible changes in the sediment were in colour and hardness. The sandstone was much tougher than its unbaked counterparts and could be described as a hornfels.

2. *Tiers Formation*

An assemblage of grey-green sediments ranging in grade from shale to medium sandstone constitutes the Tiers Formation. Boundaries between beds are frequently gradational and individual members are generally somewhat thinner than beds of the other Triassic formations. As well as the broader alternation of sandstones and shales, the

shales themselves are faintly "pencil" banded. The sandstones are of the "felspathic" type similar to those of the Brady Formation but without coal or carbonaceous bands and with the characteristic colour of greenish-grey in fresh rock and greenish-brown (khaki) in the weathered material. The black shales which constitute a large proportion of the formations above and below the Tiers Formation represent only about 5 per cent of this formation and occur near the middle of the formation.

Plant fragments occur in several beds in profusion but the majority of beds are barren.

The basal member is somewhat thicker and coarser than other sandstones in the formation. It contains well rounded quartz grains constituting some 30 per cent of the rock, a feature not apparent in other members of the formation.

The formation outcrops at a number of points on the Lake Highway (Map Square 4686) and occasionally on the upper slopes of the Tiers south of the Palmer Rivulet. The complete sequence is available in the drill cores mentioned earlier where the measured thickness is some 280 feet. The Tiers Formation rests conformably on the Cluan Formation.

3. *Cluan Formation*

The Cluan Formation consists of fine to medium grained sandstones, frequently highly quartzose, interbedded with dark-grey shales and occasional siltstones. Zones of "pencil banded" cream sandstone and dark-grey shale are not uncommon. The high proportion of dark-grey shales (about 50 per cent of the formation thickness) and absence of green shales distinguishes the formation from the Tiers Formation while the presence of numerous highly quartzose sandstones distinguishes it from the Brady Formation. While shales and sandstones are present in approximately equal proportions the formation grades from predominantly sandstones near the base to predominantly shale near the top.

Towards the middle of the formation several beds of siltstone with abundant plant fragments occur but generally the sediments are barren. Throughout the formation restricted clay-pellet bands occur in the sandstones. Neither of these features appear to be sufficiently persistent laterally to represent reliable marker horizons.

Sandstones of the Cluan formation outcrop on the Tiers face but outcrops are of limited extent. More persistent outcrops are present on Cluan Tier (Map Square 4786). The drill cores mentioned earlier represent the most complete record with a measured thickness of 460 feet. The Cluan Formation rests conformably on the Ross Formation.

The Cluan Formation is a receptive host rock for the dolerite intrusion. The dolerite contact occurs within the Cluan Formation over much of the area. On the Tiers from Drys Bluff to the Palmer River, on Cluan Tier and on McRae Hills the dolerite sheet rests on Cluan sediments. Moreover the strong sandstones of the Cluan apparently impede transgression across the sequence and the pure sill-form of the dolerite sheet is maintained over long distances.

4. *Ross Formation*

The Ross Formation consists predominantly of impure, medium-grained quartz sandstone. In fact, drill holes which have penetrated this formation for some 270 feet reveal nothing but sandstone with only minor variations in grain-size. Cliff faces up to 300 feet in height (4820 E. 8507 N.) reveal minor lenses of claystone but no rock types other than sandstone, which is persistent laterally.

The sandstone, light-grey when fresh, weathers yellow and this weathering persists for hundreds of feet in drill holes suggesting that the sandstone is reasonably permeable.

Outcrops are frequent on the Tiers face and a fairly persistent line of cliffs marks this formation. The measured thickness is some 650 feet.

Permian System

Gently dipping Permian rocks underlie the Triassic sequence apparently disconformably though no exposed contact between the two could be found. The Permian rocks rest unconformably on Pre-Cambrian rocks to the east of the mapped area. Within the area no pre-Permian rocks have been encountered either in surface mapping or diamond drilling. Within the system the formations are apparently conformably related.

The thickness of the Permian sequence is in excess of 2000 feet and outcrops occur fairly persistently on the lower slopes of the Tiers.

Diamond drilling in connection with investigations of the proposed Great Lake North power development was carried out along two lines on Map Square 4886 joining the point 4869 E. 8545 N. with points 4825 E. 8505 N. and 4805 E. 8515 N. Twenty-three holes ranging in depth from 50 feet to 1100 feet were drilled in Permian rocks and a generalised Permian sequence based on drill logs is shown in the text figure.

The system is predominantly marine, the lithology being influenced, apparently, by the glaciation of the adjacent land surface. The depth of the seas during sedimentation, as inferred by the grain-size of the sediments and the associated fossil types, varies over quite wide limits. Inspection of the graphic log reveals the rhythmic nature of these changes.

1. *Jackey Formation*

Freshwater shales bearing abundant, but so far not diagnostic, plant fragments have been found at a number of points between the Ross Formation and the Permian mudstones. The nature of the contact between this and adjacent formations is not known and it is a matter of conjecture as to whether the formation belongs to the Permian or the Triassic sequence. It has been suggested that it may be correlated with the Cygnet freshwater Permian rocks.

The estimated thiekness of these shales and the accompanying minor sandstones which make up the formation is 140 feet. The type area of the formation is in the catchment of Jaekeys Creek at 4663 E. 8660 N. Better exposures of this formation have sinee been reported from Western Creek to the north-west of the mapped area.

Ferntree Group

The Ferntree group of six formations eonsists of alternations of thin eonglomeratic sandstones with thiek mudstones. This group, whieh has been reeognised at a number of plaees throughout the State, has been subdivided in this area into six formations with a total thiekness approaehing 700 feet.

2. *Eden Formation*

The topmost formation of the Ferntree Group consists of grey to blaek mieaeeous mudstone apparently devoid of erraties and marine fossils. It is extremely fine-grained, massive and of medium hardness and eonsists essentially of quartz, felspar and miea. The estimated thickness of this formation is 20 feet. The type locality is in Map Square 4686 at 4665 E. 8663 N. where the formation is exposed in a ereek-bed.

3. *Blackwood Formation*

The Blaekwood Formation eonsists of well-rounded, white quartz pebbles up to one ineh in diameter, but largely of quarter ineh diameter, in a matrix of poorly sorted sandstone consisting essentially of quartz and felspar. It is an extremely resistant formation forming well marked benehes on the Tiers face. The thiekness of the formation varies from 2 to 5 feet. Beeause of its limited thickness and persistent outerop it eonstitutes an exeellent marker formation. The type loeality of this formation is on the spur below Mt. Blaekwood. A prominent and typieal beneh at about the 2000 feet eontour is underlain by this formation whieh forms a small searp at the margins of the beneh (4810 E. 8524 N.). A more easily aceessible exposure oeeurs in a waterfall on Map Square 4686 (4665 E. 8663 N.).

4. *Drys Formation*

The Drys Formation consists predominantly of mieaeeous mudstone with oecasional bands of quartz mudstone in whieh angular grains of elear quartz are apparent in the hand speeimen. The mieaeeous mudstone is essentially similar to the Eden Mudstone though somewhat lighter in eolour. Miea plates on the bedding planes assist parting parallel to the bedding. In the quartz mudstones miea is mueh less eonspieuous and the roek does not part readily.

Erraties of quartzite, slate and miea sehist up to 2 inehes in diameter oeeur in this formation but are not numerous. Four might be eneountered in 100 feet of drill eore. Marine fossils were not found.

Outcrops of this formation are not particular good but the formation usually oeeupies steep slop with only a thin soil eover so that frequent patch of outerop may be found and these may be rapi extended with little effort. The type area is on eastern spur of Drys Bluff on Map Square 4 (4785 E. 8620 N.). The measured thiekness of t formation is somc 350 feet.

5. *Palmer Formation*

The Palmer Formation is a poorly sorted quar felspar sandstone eontaining pebbles (or erratic of slate, miea sehist and quartzite. The grou mass is light-grey when fresh but weathers cre It forms benehes bounded by a small searp on Tiers faee and produees waterfalls in the strea The mudstones immediately above and below sandstone show an inerease in grain size towa this formation but the boundaries of the sandst are well-defined. Beeause of its limited thickn and persistenee of outerop the formation is exeellent marker for mapping. It may be d tinguished from the Blaekwood Formation by absenee of well-rounded, milky quartz pebbles the presenee of fairly numerous pebbles of quartz schist and slate.

The type loeality of this formation is a wat fall on a braneh of the Palmer River in Map Squ 4885 (4816 E. 8519 N.).

6. *Springmount Formation*

The Springmount Formation is a banded m stone in whieh the banding results from alter tions of medium-grey mieaeeous mudstone lighter grey quartz mudstone. The bands vary thiekness from fraetions of an ineh to several fe The essential differenee between the two types mudstone lies in the grain size of the quartz a thc relative abundanee of mica. The quartz m stone is more resistant than the miea mudst and forms most of the outerops of this formati

Oeeasional erraties have been noted in t formation but no fossils have been found. T thiekness of the formation is approximately feet. The type loeality is on the Springmo property in Map Square 4786 (4790 E. 8623 A eomplete sequenee through this formation been ootained in drill hole 5004 (4822 E. 8509 N

7. *Garcia Formation*

The basal formation of the Ferntree Group the Gareia Sandstone. It is a grey, poorly sor sandstone eonsisting essentially of quartz and spar and eontaining numerous quartzite, sehist slate pebbles (erraties) Marine fossils, nota braehiopods, oeeur in the lower horizons and se to distinguish this formation from the other sa stones of the group. Like those sandstones it fo benehes on the Tiers face. The thiekness of formation varies from 20 to 30 feet.

The type loeality of this formation is at the h of Gareia Creek on Map Square 4885 where sandstone forms a broad beneh bordered by a sc (4806 E. 8585 N.). Numerous seetions of t formation have been obtained in drill cores.

This formation may well be correlated with the Risdon Sandstone of the Hobart area but the possibility that the Palmer Formation is the Risdon equivalent has influenced the author to introduce a new name for the basal member of the Ferntree Group in this area.

Woodbridge Group

The Woodbridge Group in this area consists of approximately 270 feet of sandstones and mudstones with occasional bands of limestone. Erratics occur sporadically throughout the group and marine fossils are common, two of the formations having very rich faunas. The group has been divided into three formations in this area.

8. *Weston Formation*

The uppermost formation of the group consists of dark-grey micaceous mudstone with a rich bryozoan fauna and occasional brachiopods. Several thin members of quartz mudstone with macroscopic angular quartz grains occur within the formation. The thickness of this formation varies between 30 and 40 feet.

The type locality of this formation is on Map Square 4785 where the mudstone outcrops in a creek bed at 4785 E. 8597 N. The formations above and below are also well exposed at this locality. A number of drill holes referred to earlier penetrate this formation.

9. *Dabool Formation*

The Dabool Formation consists of medium quartz and felspar grains in a mudstone matrix. Pebbles (erratics) occur in layers throughout the formation. A rich brachiopod fauna, also distributed in layers, characterises the formation. Like other Permian sandstones it forms benches on the Tiers slope.

The formation thickness varies between 25 and 40 feet. The type locality of the formation is the particularly well developed bench on Map Square 4885 at about the 1150 feet contour between Wood-side Rivulet and Dabool Creek (4865 E. 8508 N.). A more accessible locality is a creek bed at 4807 E. 8543 N. The formation has been penetrated in a number of the drill holes referred to previously.

10. *Meander Formation*

The Meander Formation, which is the basal formation of the Woodbridge Group, includes a number of lithologic units. A typical bore-log through this formation is given below:

0-110 feet:	A banded mudstone in which the banding results from alternations of quartz mudstone and mica mudstone. The individual bands are up to 15 inches in thickness. Brachiopod fragments were encountered at 52 feet and 68 feet and a layer of pebbles at 69 feet.
110-112 feet:	A limestone containing brachiopods.
112-170 feet:	A banded mudstone consisting of alternations of mica mudstone and grey quartz mudstone which includes numerous angular rock fragments up to a quarter of an inch across. Three inches of limestone was encountered at 140 feet and pebble layers at 120, 121, 123, 141 and 158 feet. At 150, 166 and 169 feet a mesh of calcite veins represented some 30 per cent of the core for a distance of several inches.
170-171 feet:	Grey "worm-cast" quartz sandstone. (Of doubtful lateral persistence.)
171-172 feet:	White, medium grained, quartz sandstone.
172-182 feet:	Half-inch alternations of grey, fine grained sandstone and black mica mudstone.
182-183 feet:	Quartz conglomerate with well-rounded white pebbles up to one inch in diameter. (Of doubtful lateral persistence.)
183-195 feet:	Half-inch alternations of grey, fine-grained sandstone and black mica mudstone.

The formation thickness is fairly constant and a number of measured thicknesses between 180 feet and 200 feet have been obtained. The type locality is the road cutting on Map Square 4886 (4820 E. 8628 N.). Several drill holes penetrated this formation.

Liffey Group

Well-sorted, medium grained, quartz sandstones and fissile, plant bearing and carbonaceous shales constitute the Liffey Group. Only the uppermost formation in which a brachiopod has been found is thought to be of marine origin. The group outcrops well as a fairly persistent line of cliffs in the Liffey Valley (Map Square 4786) and elsewhere outcrops in stream courses where it produces waterfalls. The group thickness varies from 90 to 100 feet and is divided into four formations in this area all of which have been penetrated in a number of drill holes referred to previously.

11. *Creekton Formation*

The Creekton Formation is a medium-grained quartz sandstone characterised by an abundance of "worm-casts". The origin of the organic traces referred to as "worm-casts" has not been definitely established. The fresh rock is a mottled grey rock with patches of black which have the appearance of tar. The weathered rock retains its mottled appearance in lighter shades.

The formation thickness varies from 7 to 12 feet and because of this restricted thickness and its characteristic appearance (it is the only laterally

persistent "worm-cast" member in the Permian sequence) it represents an excellent marker formation.

The type locality is near the Creekton homestead on Map Square 4885 (4879 E. 8597 N.) where it forms a small cliff.

12. *Woodside Formation*

The Woodside Formation is a flaggy, well-sorted, medium grained, quartz, mica sandstone with several black shale bands up to one foot in thickness. Several lenses of well-rounded quartz conglomerate have been noted near the top of the formation. The flaggy character of the sandstone arises from a distribution of mica plates on bedding planes.

The formation thickness varies between 25 and 40 feet. The formation type locality is the gorge of an un-named tributary of Woodside Creek on Map Square 4885 (4870 E. 8510 N.).

13. *Kopanica Formation*

The Kopanica Formation consists essentially of grey to black shales with thin bands of white sandstone. The shales are micaceous and in some cases carbonaceous and plant fragments are quite common on several horizons. The sandstone bands which may be as much as six inches thick are a medium-grained sandstone similar in every respect to that of the formations above and below the Kopanica Formation.

The thickness of the formation and the percentage of sandstone bands within it vary over quite wide limits. Measured thicknesses of from 5 to 20 feet have been obtained and sandstone percentages may be as high as 20 per cent. The type locality is in a waterfall adjacent to the Kopanica homestead on Map Square 4885 (4803 E. 8573 N.).

14. *Flat-Top Formation*

The Flat-Top Formation consists of a flaggy, well-sorted, medium grained, quartz, mica sandstone with numerous dark-grey shale bands. It can be distinguished from the Woodside Sandstone only by the presence of numerous shale bands.

An interesting feature of this formation is that in some areas it is capped with up to seven feet of "worm-cast" sandstone. This particular member is apparently not persistent laterally but in those areas where it occurs two cycles of similar thickness embracing shale, sandstone and "worm-cast" sandstone may be recognised. In some areas a third "worm-cast" sandstone, underlain by sandstone and mudstone occurs near the base of the Meander Formation. These areas may be interpreted as showing three cycles similar in thickness and composition.

The formation thickness varies from 20 to 35 feet. The type locality is on the Flat-Top property where this formation forms the surface and bounding scarp of a small plateau on Map Squares 4885 (4868 E. 8523 N.).

Golden Valley Group

The Golden Valley Group contains a diversity of sediments containing marine fossils, sometimes in profusion, and boulders (erratics) of quartzites, slates and schists. Sandstones, mudstones and limestones are represented. Outcrops of this group are generally poor throughout the area and for this reason the group has been sub-divided into only three formations. On drill core information further sub-division could be made but this seems undesirable as drill core information is rarely available.

The group thickness is approximately 170 feet.

15. *McRae Formation*

The McRae Formation, while predominantly of mudstone, contains bands of marl up to one foot in thickness and is capped by 10 feet of dark-grey sandstone composed of small angular rock fragments in a mudstone matrix. A typical drill log of this formation is given below:

0-9 feet:	Grey, rock-fragment sandstone.
9-78 feet:	Mica mudstone with bands of marl at 20 feet and 50 feet, occasional erratics (to 2 inch diameter) and fossil detritus bands.
78-108 feet.	Alternating bands of mica mudstone and quartz mudstone up to 2 feet thick. Numerous layers up to 1 foot in thickness of pebbles and fossil fragments. One foot of marl at 102 feet.
108-118 feet:	Mica mudstone.

The formation thickness varies between 100 and 120 feet. The type locality is a road cut near the McRae Hills property on Map Square 4885 (4895 E. 8594 N.). A number of drill cores are available in this formation.

16. *Billop Formation*

The Billop Formation consists essentially of a grey sandstone composed of clear rounded quartz grains in a calcareous matrix underlain by a quartzite conglomerate with a similar matrix which includes numerous brachiopod fragments. The two members are of approximately equal thickness. Greenish fragments which may be glauconite are present in the sandstone member. On weathering the matrix is removed and a characteristic cream porous sandstone remains.

The formation thickness varies between 10 and 20 feet. The formation forms benches on the lower slopes of the Tiers. The weathering of the formation produces a gravel surface on these benches consisting of the sand grains and conglomerate pebbles. These deposits are used locally as a road metal.

An interesting and diagnostic feature of these gravels is the presence of an encrusting foram (*Calcitornella?*) which is visible on one surface of a large number of the quartzite pebbles.

The type locality is a bench at the foot of Billops Bluff on Map Square 4885 (4875 E. 8518 N.). The formation was penetrated in a number of drill holes.

17. *Brumby Formation*

The Brumby Formation consists of a highly fossiliferous micaceous mudstone underlain by some 5 feet of limestone which may be classed in places as a coquina limestone. The black micaceous mudstone is particularly rich in *Fenestella* and *Stenopora* while the limestone contains abundant *Spirifers* and *Eurydesma*.

The formation thickness varies between 40 and 50 feet. The type locality is a steep slope which is being undercut by Brumby Creek on Map Square 4886 (4817 E. 8618 N.).

18. *Quamby Formation*

The Quamby Formation consists of a uniform and massive dark-grey mica mudstone in which layers of pebbles and fossil detritus are prevalent towards the top of the formation but decease in frequency until they disappear entirely from the lower half of the formation.

The thickness of this formation varies between 250 and 330 feet. Very few outcrops of this formation occur in this area though good bore sections are available. The formation was defined by Wells (1954).

19. *Stockers Formation*

The Stockers Formation is a tillitic conglomerate consisting of pebbles (or erratics) of quartzites, slates and schists in a groundmass of grey mica mudstone. A number of faceted erratics and several with striations have been found in the limited outcrops of this formation. The erratics range in size from fractions of an inch to a foot in diameter. There are lenses of mudstone where erratics are absent while in other places erratics form the major portion of the rock mass. While the erratics represent a large range of rock types there are zones where particular types predominate.

The Stockers Formation probably represents the basal formation of the Permian sequence in this area, as it has been demonstrated to do in neighbouring areas, but the basement rocks have not been exposed in this area.

Only one locality of Stockers Formation outcrop is known in the area mapped. This occurs in the bed of the Palmer River on Map Square 4885 (4878 E. 8548 N.). The formation has been proved by drilling to a thickness of 340 feet.

The formation was defined by Wells (1954) in an area to the north-west of the mapped area here.

CYCLES OF SEDIMENTATION

In the Permian and Triassic sequence of this area several broad cycles of sedimentation and marked changes in mineral composition of the sediments may be recognised.

Triassic Cycle

Inspection of the Triassic sequence reveals the gradual change from predominantly sandstone deposition (Ross Formation) to alternations of sandstone and dark-grey shales in approximately equal thicknesses by the time the top of the Cluan Formation is reached. The predominantly quartzose sandstones give way to felspathic sandstones in the same period. Following a period in which the strikingly different Tiers Formation was laid down, the Brady Formation of black shales and felspathic sandstones suggests a return to conditions similar to those prevailing during Cluan deposition.

Permian Cycle

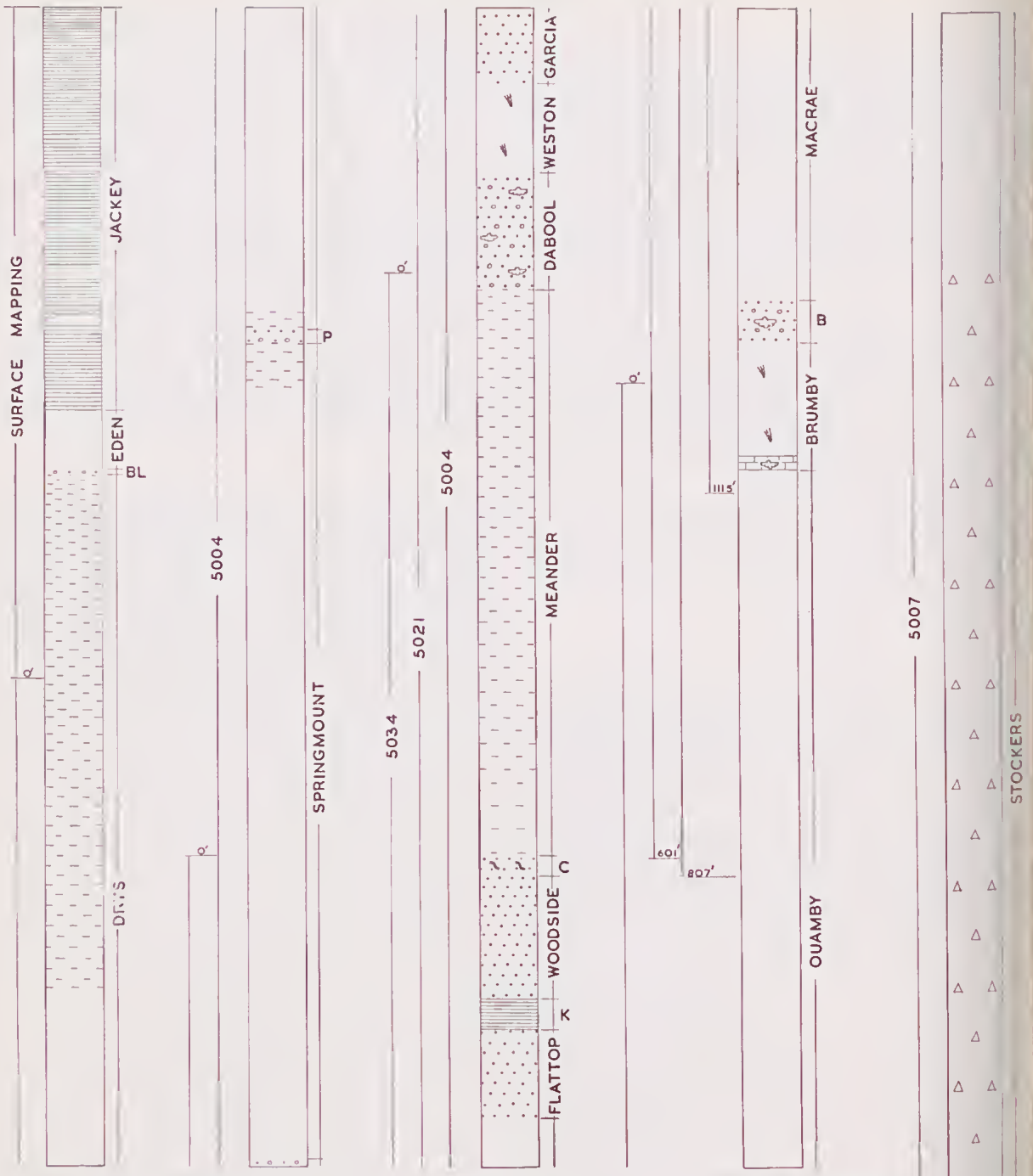
Cycles of sedimentation in connection with the Liffey Group have already been mentioned. If the marine sequences above and below this group are compared a number of strikingly similar characteristics are noted.

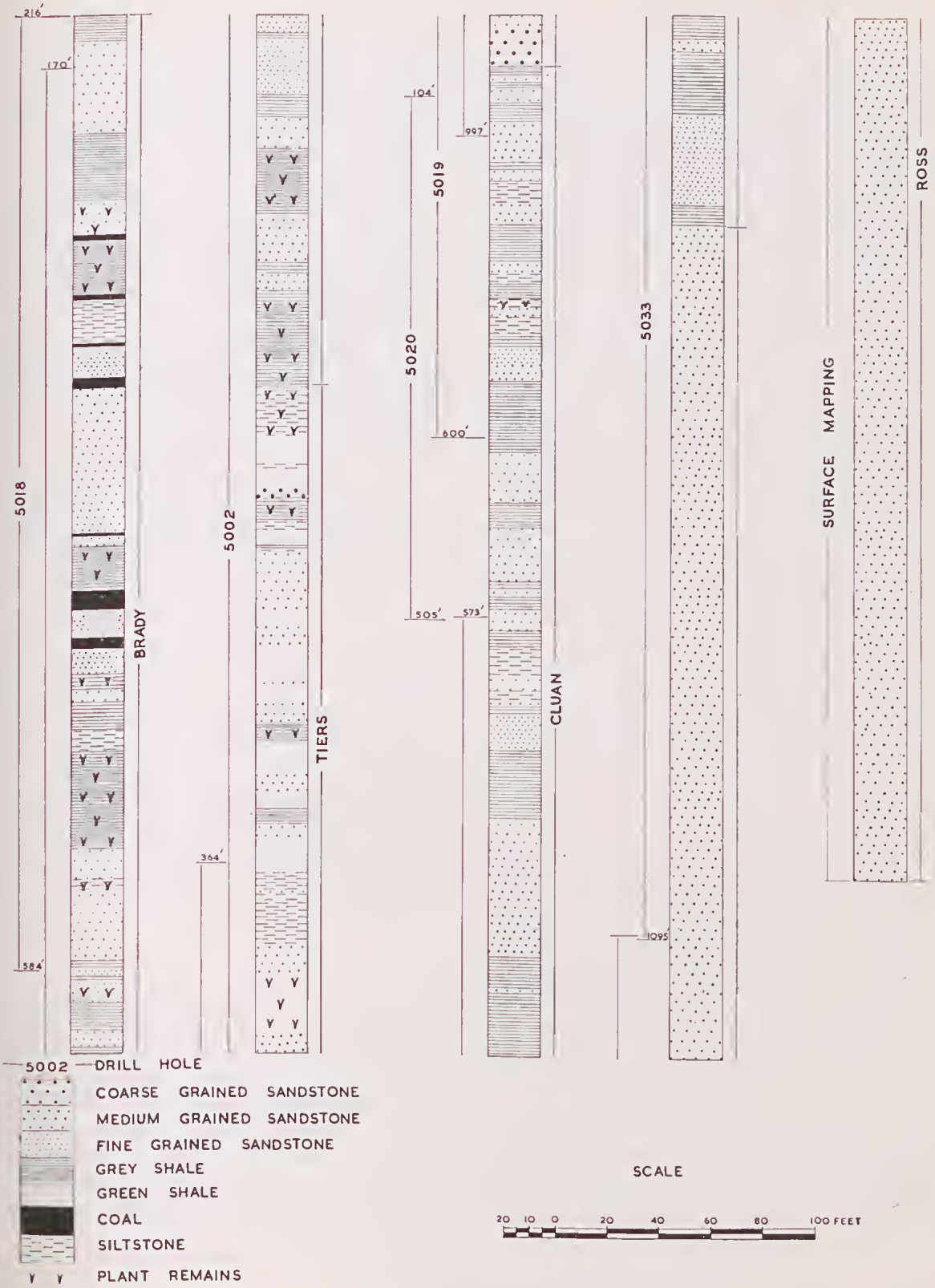
These may be demonstrated in the table below.

Formation	Rock Type	Formation
Liffey (90′)	Barren Sandstone	Palmer (5′)
McRae (115′)	Mudstone with few erratics	Springmount (280′)
Billop (15′)	Conglomeratic sandstone with Brachiopods	Garcia (30′)
Upper Brumby (35′)	Mudstone with Bryozoans	Weston (30′)
Lower Brumby (10′)	Rich Brachiopod Fauna	Dabool (40′)
Quamby (330′)	Mudstone with erratics	Meander (195′)

A further point of interest is the distribution of layers of erratics and fossil detritus in the Quamby-Golden Valley sequence. The frequency of layers increases upwards through the Quamby Formation to a maximum at the top of that formation. From a maximum in the Billop Formation the layers decrease in frequency upwards through the McRae Formation. This distribution could indicate the waxing and waning of ice action on an adjacent land surface.

GENERALISED PERMIAN SEQUENCE




216'
170'
5018
584'
BRADY
5002
364'
TIERS
104'
997'
5019
5020
600'
505'
573'
CLUAN
5033
1095'
SURFACE MAPPING
ROSS
5002 DRILL HOLE
COARSE GRAINED SANDSTONE
MEDIUM GRAINED SANDSTONE
FINE GRAINED SANDSTONE
GREY SHALE
GREEN SHALE
COAL
SILTSTONE
PLANT REMAINS
SCALE
20 10 0 20 40 60 80 100 FEET

STRUCTURE

A. Geological History

The prolonged period of sedimentation during the Permian and Triassic was terminated by widespread injection of dolerite, probably of Jurassic age. Following the intrusion of dolerite and persisting until the early Tertiary a period of peneplanation produced a laterltised and bauxitised surface. Violent bloek faulting associated with the Tertiary Epeirogeny dismembered this surface. The Central Plateau was formed fringed by a scarp with a relief of 2000 feet. East of the area further faulting in the same sense increased the relief of the Central Plateau mass over the Midland mass to well over 3000 feet.

The Tertiary basalts and related rocks found to the south and west of the area may have extended into this area only to be removed by ice action during the Pleistocene glaciation of the area.

The pattern of marshes, the presence of glacial-type deposits in these depressions and vast accumulations of large, angular dolerite boulders in parts of the area suggest that a major ice sheet moved southwards across thc area during the Pleistocene glaciation. Glacial over-deepening occurred along shear zones in the dolerite surface on the site of the present marshes.

The passing of the glacial period saw the development of a system of minor streams draining the Plateau surface into Great Lake. As the eatchment boundary of the lake corresponds closely with the Plateau, margin plateau drainage plays little part in the incision of the scarp.

As the scarp fringing the Plateau retreats the products of its erosion from a broad, gently sloping alluvial fan at the base of the scarp. These deposits are constantly being reworkcd and removed by stream action as evidenced by the almost complete lack of weathering in the underlying rock.

B. Faulting

The Tertiary epeirogeny produced a network of faults and shear zones separating tilted blocks. There is some tendency towards a general south-west dip of the sediments in this area. Divergence in the direction and amount of the dip, however, indicates that the various blocks were tilted independantly during the epeirogeny. To accommodate this tilt-variation, the faults between bloeks are often complex, a number of sub-parallel faults and erush zones representing the overall displacement between contiguous blocks. Further adjustment between bloeks has been attained in wide zones of shearing which show little evidence of any associated vertical movement of elther bounding bloek.

Because of the closeness and complexity of faulting a given fault is rarely constant in throw or direction. Throw of one fault of a system may be transferred via a transverse fault to another member of the system. An example of this may be seen ln the Tiers Fault near the north-east eorner of Map Square 4885. Here the throw on a north-north-west trending fault is transferred along a transverse fault trending west-north-west to another member of the north-north-west system. The tendency is also revealed in the disposition of the marsh deposits, as in Map Square 4785.

As far as can be ascertained all faults are normal and near-vertical. According to their direction. the faults in this area may be grouped into four systems.

(i) A system trending north-north-west conforms with the major trend of faulting recognised over much of the old "struetural core" of Tasmania. In this area the trend is not nearly as pronounced. The major fault of the area, the Tiers Fault, belongs to this system as do some minor faults and shear zones

(ii) A system trending east-north-east are the most numerous and also the most persistent laterally though the throws rarely exceed 200 feet There is a tendency, if only slight, to a radial arrangement about a centre west-south-west of thc area. This is well illustrated by the faults and shears of Map Square 4785.

(iii) A minor system trending north-north-east consists of members of small throw and restricted lateral persistence. An interesting development in the shear pattern is evident on Map Square 4785 where a combination of shears trending north-north-east and those trending east-north-east produce a resultant linear trending north-north-west. As this direction coineides with Trend (i) it suggests that there may be a structural weakness in the basement rocks in this direetion.

(iv) A fourth system, not well represented numerically in this area but including a major fault between Cluan Tier and Drys Bluff (Map Square 4786). trends west-north-west. This system is best developed in the north of this area.

From a regional view-point the fault evidence suggests that the area is perhaps marginal to the Pre-Cambrlan "core" of Tasmania and that it lies east-north-east of this eore. In support of this theory we have the north-north-west trend less strongly developed than in other areas to the south and south-west, the tendeney to a radial arrangement about a point west-south-west of this area and quite a strong development in the north of this area of a west-north-west system.

C. Origin of the Tiers

While the formation of the Western Tiers in the east and north-east of the area may be attributed to parallel retreat of scarps formed by the Tiers Fault and Cluan Fault it should be noted that the searp in the west of the area (Map Square 4686) is of a different orlgin. No fault of any magnitude occurs between Quamby Bluff on the northern margin of the Map Square 4686 and the Tiers proper in the south of this Map Square. Yet the scarp formed here is remarkably like those which owe their origin to faulting. It appears that this western portion of the Tiers was formed by stream incision of a sheared zone belonging to the west-north-west system.

D. Major Dolerite Transgressions

It has been noted that the lower boundary of the dolerite sheet within the mapped area occurs at various levels in the Triassic sequence. Over a large portion of the area the dolerite is in contact with the Cluan Formation. This disposition of the dolerite persists on the Tiers face from a point immediately east of the upper Liffey Valley (Map Square 4686) to a point on the Palmer River Valley on Map Square 4785 (4775 E. 8510 N.). A short distance beyond these points, on the Lake Highway on Map Square 4686 and at Mt. Blackwood in the south-east corner of Map Square 4785 the host rock of the dolerite is the Brady Formation. Thus major transgressions have occurred near the points mentioned. It has not been possible to delineate the plane of these transgressions, if in deed it is a plane, but geophysical surveys carried out by the Bureau of Mineral Resources and subsequent diamond drilling have proved the presence of a transgression of similar magnitude immediately to the south of the Palmer Valley transgression (beyond the mapped area) which is probably an extension of that transgression.

It is perhaps significant that the general level of the plateau rises steeply in the same sense as the transgressions in both of these areas.

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